Computer Comm. Networks

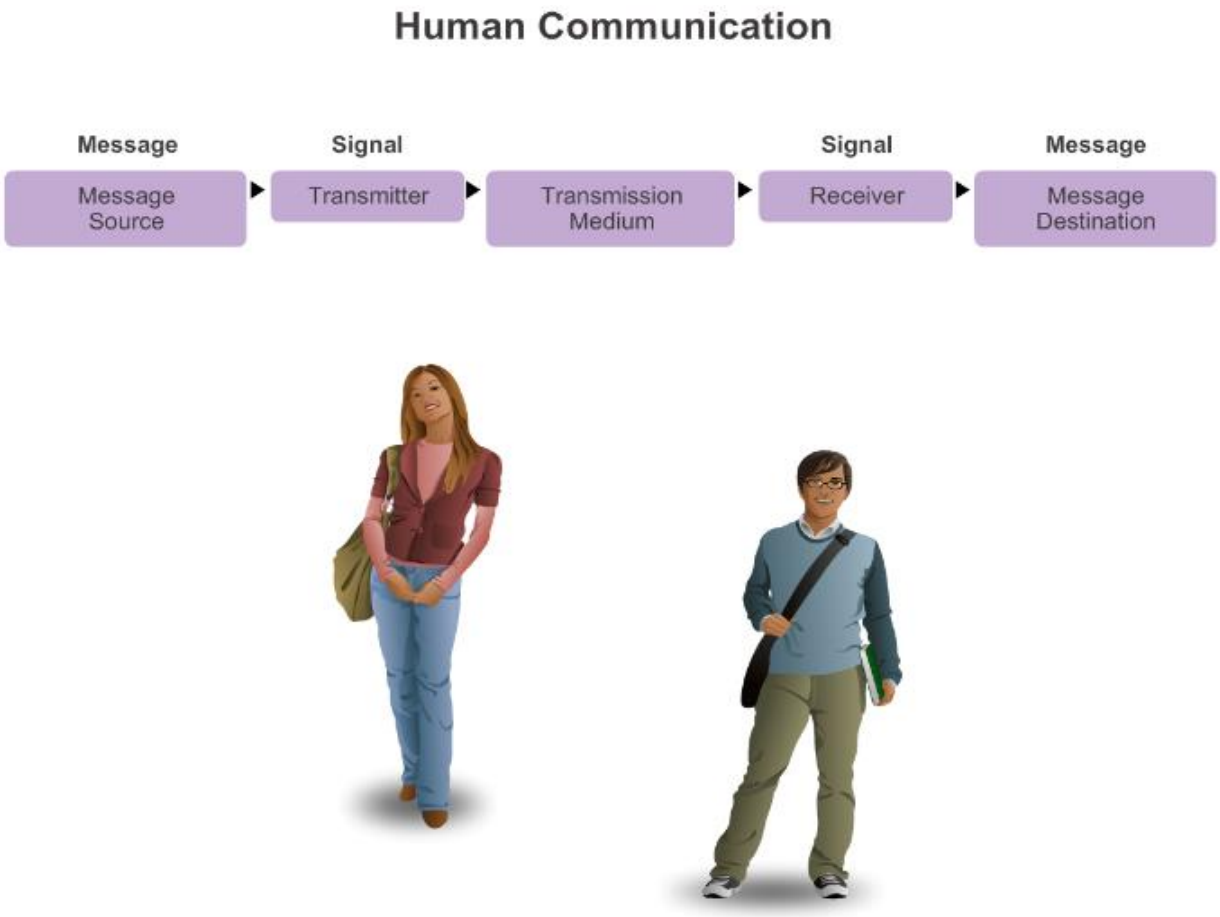
4 th year Comm.

Lect. 2

L

Network Reference Models

What is Communication?



Establishing the Rules

Establishing the Rules

- An identified sender and receiver
- Agreed upon method of communicating (face-to-face, telephone, letter, photograph)
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgement requirements

The Rules:

Message Encoding

The Rules

Message Size

The size restrictions of frames require the source host to break a long message into individual pieces that meet both the minimum and maximum size requirements.

This is known as segmenting.

Each segment is encapsulated in a separate frame with the address information, and is sent over the network.

At the receiving host, the messages are de-encapsulated and put back together to be processed and interpreted.

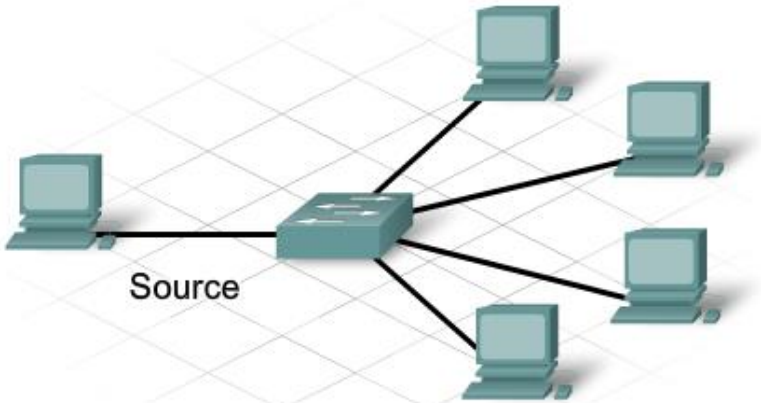
- Segmenting message benefits
  - Different conversations can be interleaved
  - Increased reliability of network communications

- Segmenting message disadvantage
  - Increased level of complexity

The Rules

Message Delivery Options

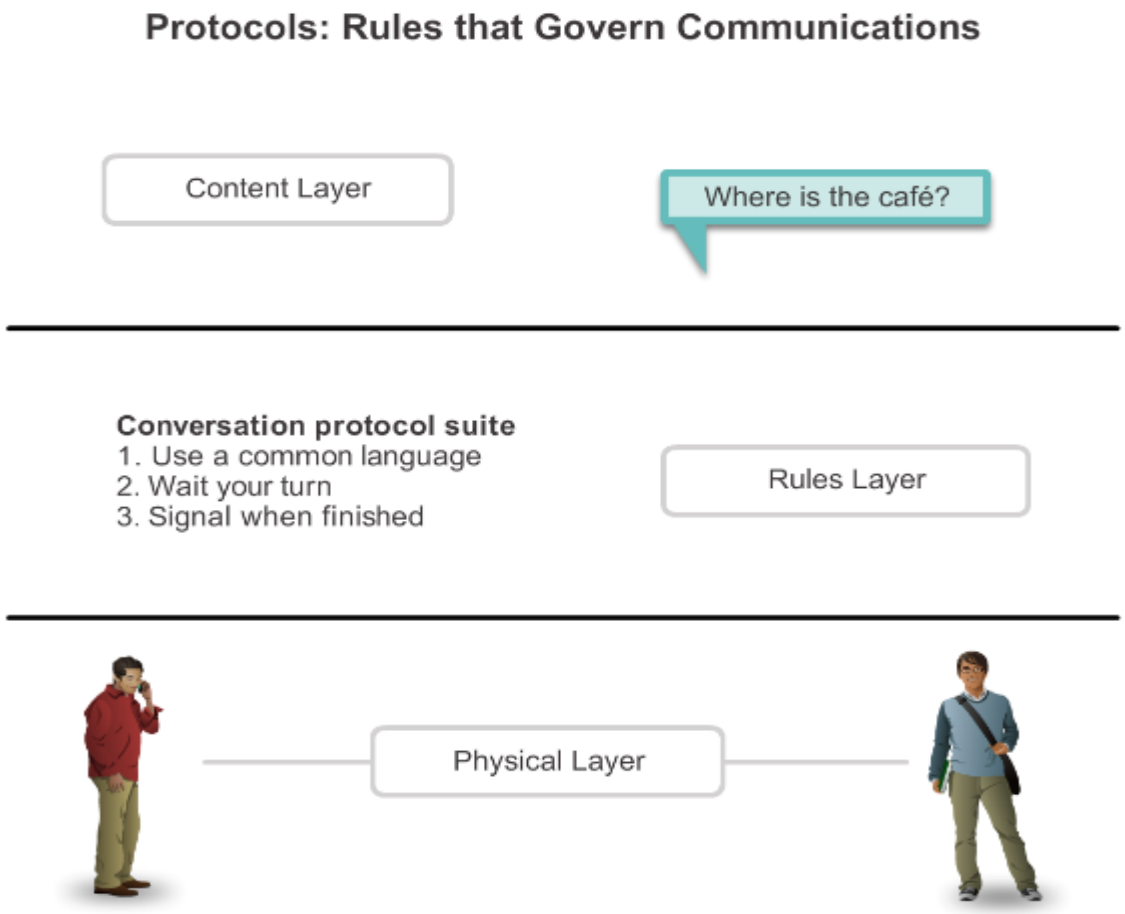
Unicast | Multicast | Broadcast



Unicast | Multicast | Broadcast

Protocols

Rules that Govern Communications



Protocol suites are sets of rules that work together to help solve a problem.

Three-Layer Model

- Network access layer
- Transport layer
- Application layer.

Consider a file transfer between two computers. Tasks to be performed are :

- The source system must either activate the direct data communication path or inform the communication network of the identity of the desired destination system.

- The source system must ascertain that the destination system is prepared to receive data.

- the file transfer application on the source system must ascertain that the file management program on the destination system is prepared to accept and store the file for this particular user.

- If the file formats used on the two systems are incompatible, one or the other system must perform a format translation function.

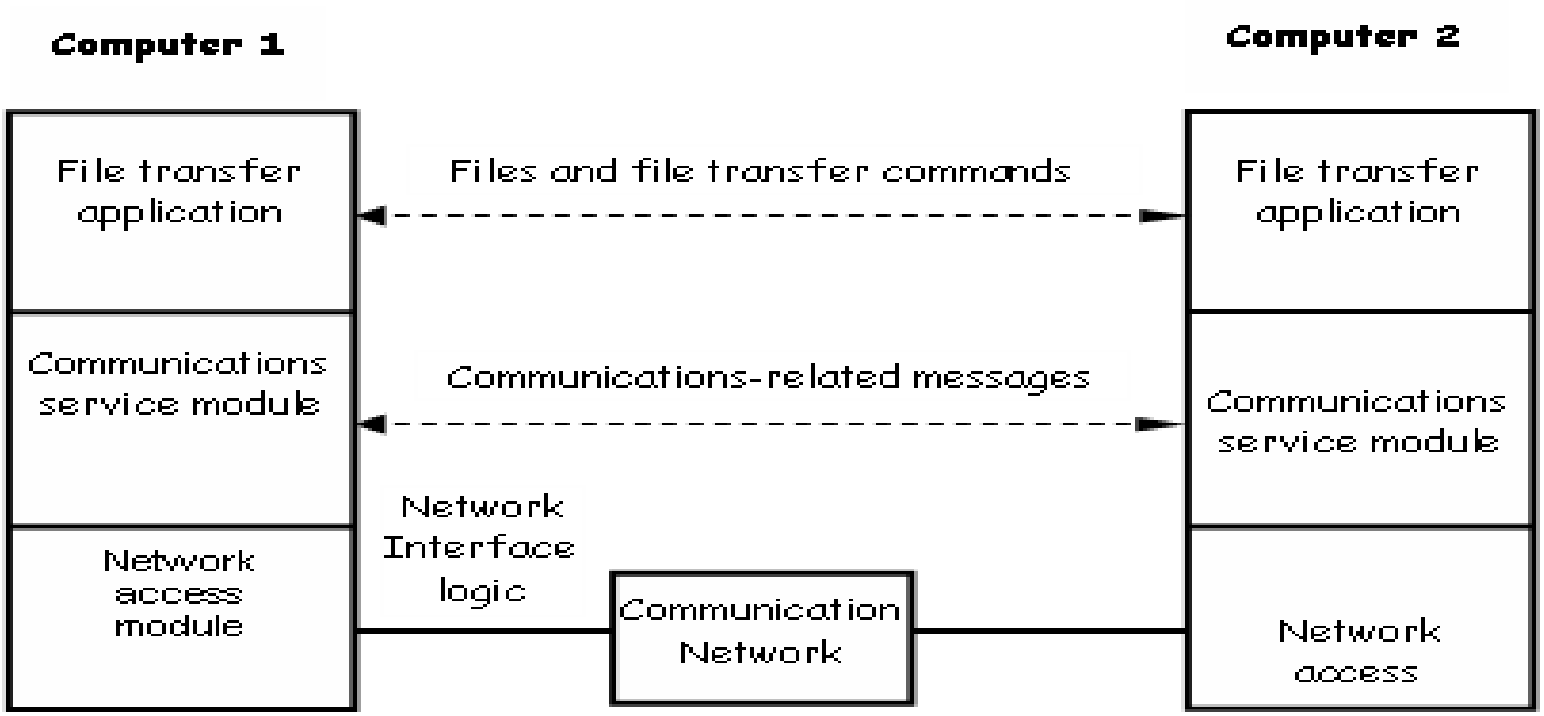


Fig. 3.1: A simplified architecture for file transfer.

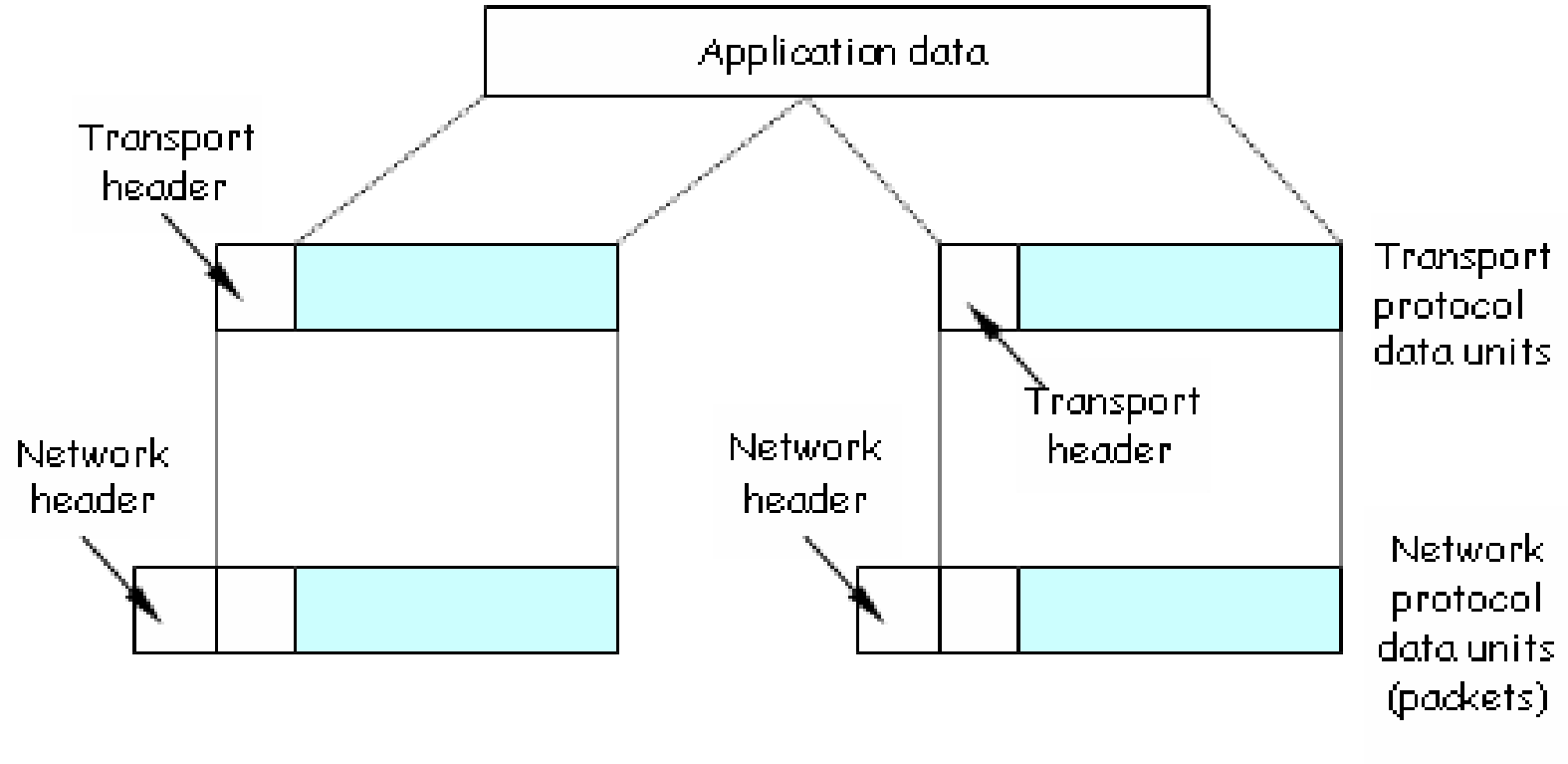


Fig. 3.3: Protocol data units.

The Seven-Layers of the OSI Reference Model

- It breaks network communication into smaller, simpler parts that are easier to develop.
- It facilitates standardization of network components to allow multiple-vender development and support.
- It allows different types of network hardware and software to communicate with each other.
- It prevents changes in one layer from affecting the other layers, so that they can develop more quickly.
- It breaks network communication into smaller parts to make learning it easier to understand.

The principles that were applied to arrive at the seven layers are:

- A layer should be created where a different level of abstraction is needed.
- Each layer should perform a well-defined family of functions distinct from other layers.
- The layer boundaries should be chosen to minimize flow across the interfaces.
- The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not because unwieldy.

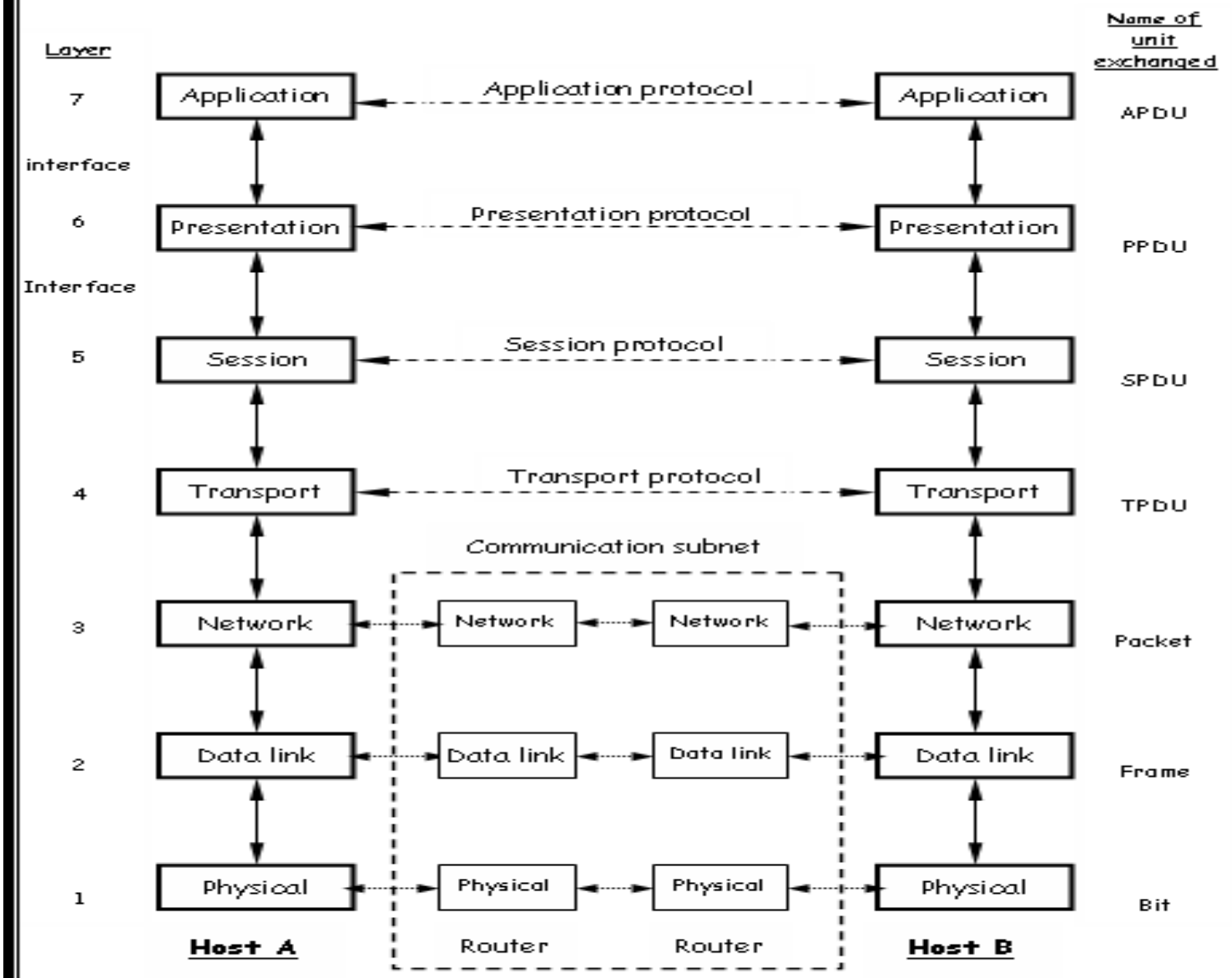


Fig. 3.4: The OSI reference model.

- **Advantages of standards:**

  1. Many computers from all the world can connect together, because they are using the international standard.

  2. Easier maintenance and installation because you get used on the standard.

- **Disadvantages:**

  1. Problems Occur in Standards, it will be international problem.

  2. All companies and manufactures must follow the standards instead of developing new techniques.

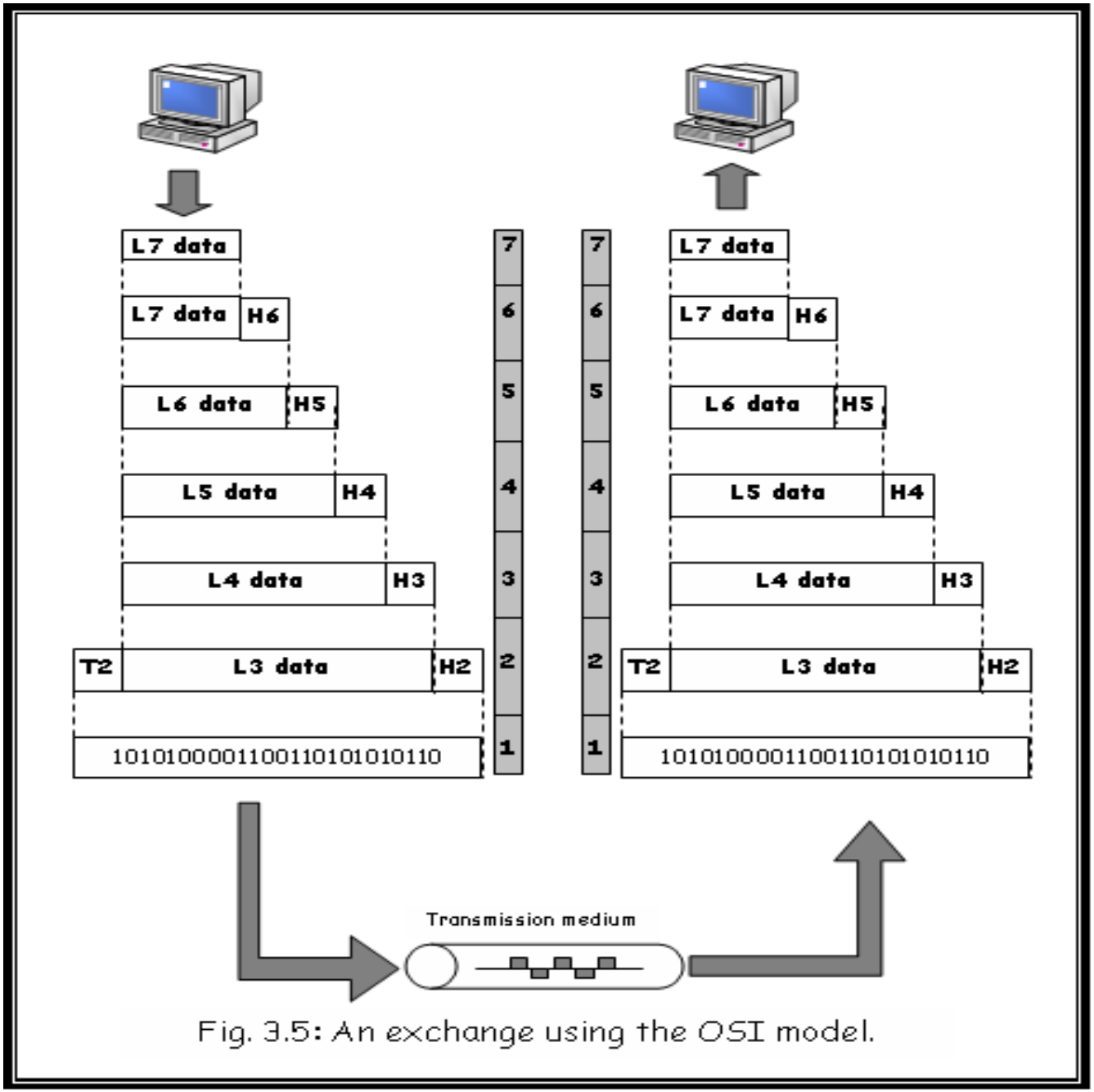


Fig. 3.5: An exchange using the OSI model.

The physical layer

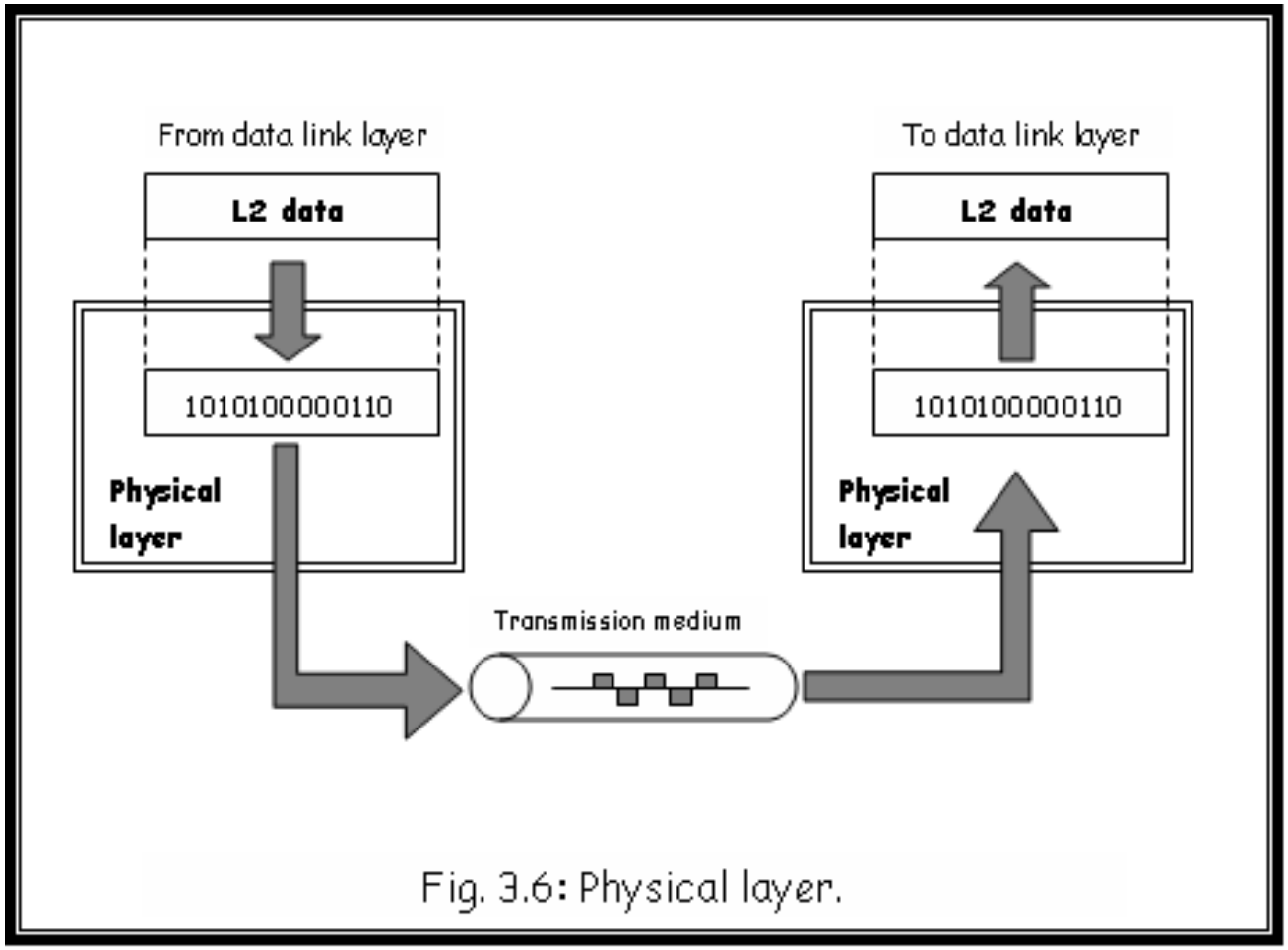


Fig. 3.6: Physical layer.

The physical layer responsibilities

1. Determines physical characteristics of interfaces and media.
2. Representation of bits: Data in this layer consists of stream of bits. The bits must be encoded into signals for transmission. It defines the type of encoding i.e. how 0's and 1's are changed to signal.
3. Data rate adjustment: This layer defines the rate of transmission which is the number of bits per second.
4. Synchronization of bits: It deals with the synchronization of the transmitter and receiver. The sender and receiver are synchronized at bit level.
5. Line configuration: This layer connects devices with the medium: Point to Point configuration and Multipoint configuration.
6. Physical topology: Devices must be connected using the following topologies: Mesh, Star, Ring and Bus.
7. Transmission mode: Physical Layer defines the direction of transmission between two devices: Simplex, Half Duplex, Full Duplex.

The data link layer

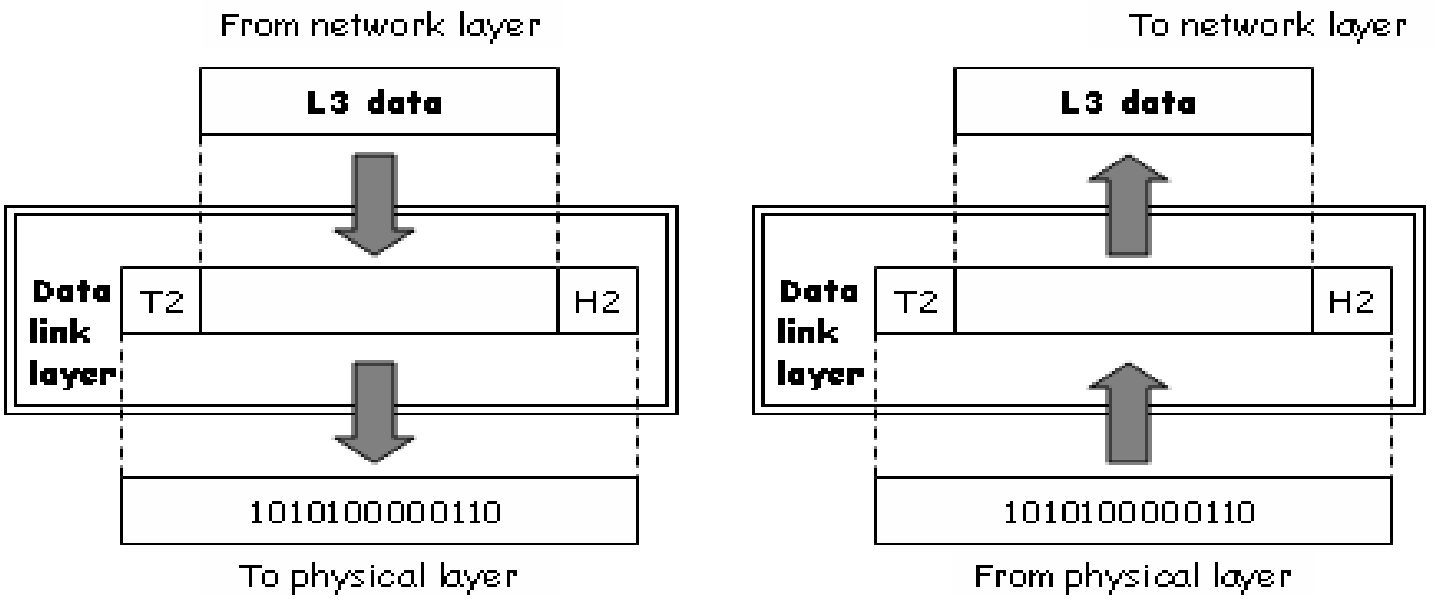


Fig. 3.7: Data link layer.

The data link layer responsibilities

- Data link layer is most reliable node to node delivery of data. It forms frames from the packets that are received from network layer and gives it to physical layer. It also synchronizes the information which is to be transmitted over the data. Error controlling is easily done. The encoded data are then passed to physical.
- Error detection bits are used by the data link layer. It also corrects the errors. Outgoing messages are assembled into frames. Then the system waits for the acknowledgements to be received after the transmission. It is reliable to send message.

The data link layer responsibilities

- **Framing** i.e. divides the stream of bits received from the network layer into manageable data units called frames
- **Physical addressing** i.e. adds a header to the frame to define the physical address of the sender (source address) and/or receiver (destination address) of the frame.
- **Flow control** to prevent overwhelming the receiver.
- **Error control** to detect and retransmit damaged or lost frames & prevent duplication of frames.
- **Access control** to determine which device has control over the link at any given time when two or more devices are connected to the same link.

MAC Address

The Media Access Control (MAC) address is just as important as the IP address. The MAC address is a unique value associated with the network adapter (NIC). MAC addresses are known as the hardware addresses or physical addresses. They uniquely identify the adapter on the LAN.

MAC Address

Format of the MAC address:

MM:MM:MM:SS:SS:SS

or

MM-MM-MM-SS-SS-SS

The first half of the MAC address contains the ID number of the adapter manufacturer. These IDs are regulated by an Internet standards organization. The second half of the MAC address represents the serial number assigned to the adapter by the manufacturer. . During the manufacturing process, the vendor "burns" a specific MAC address into each network card's ROM.

MAC Address

Format of the MAC address:

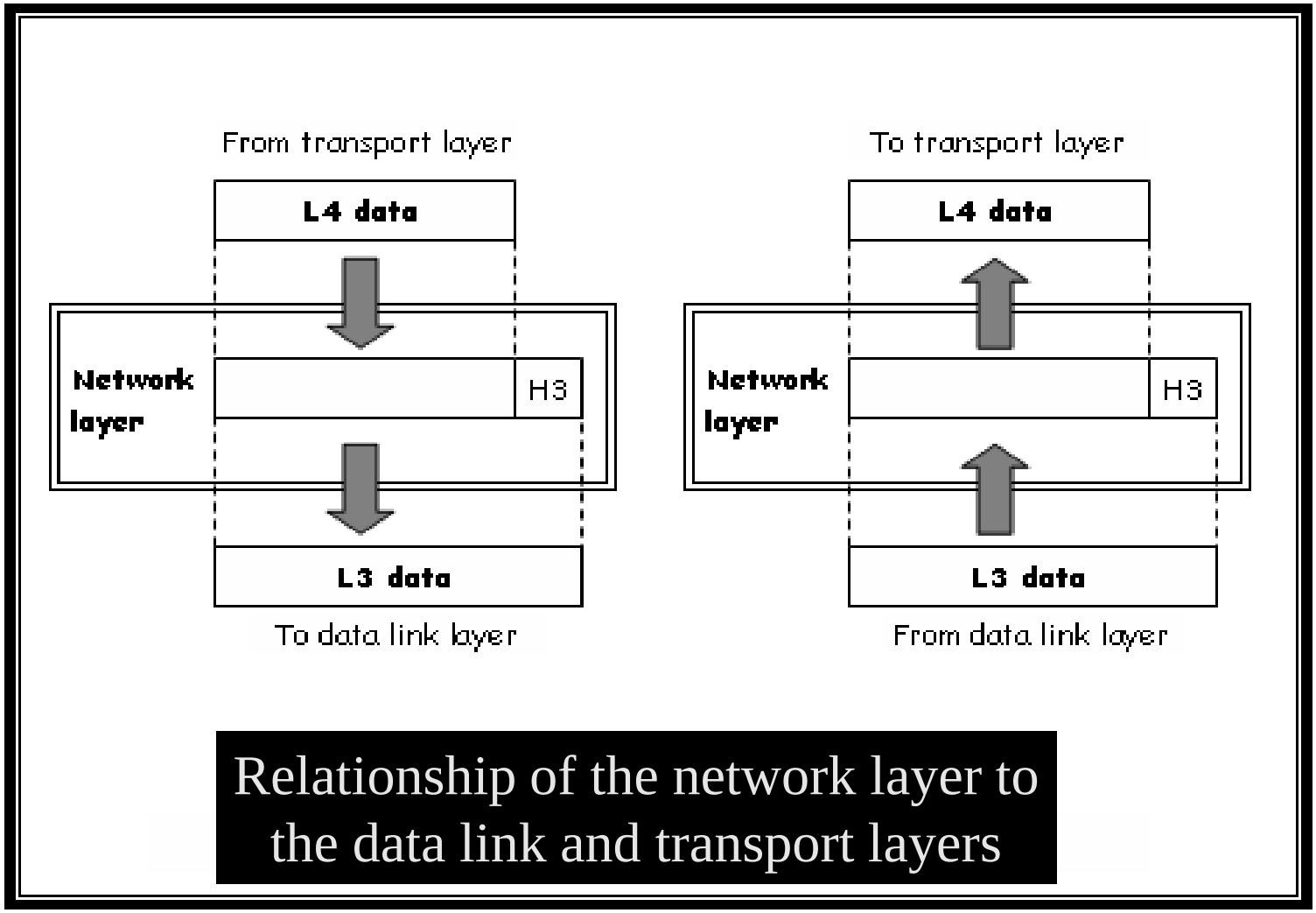
The following prefix indicates the manufacturer is Intel Corporation:

00:A0:C9:14:C8:29

The network layer

- **Logical addressing:** adds a header to the packet coming from the upper layer that, among other things, includes the logical addresses of the sender and receiver.
- **Routing:** When independent networks or links are connected together to create an inter-network (a network of networks) or a large network, the connecting devices (called routers or gateways) route the packets to their final destination.

Relationship of the network layer to the data link and transport layers



Relationship of the network layer to the data link and transport layers

The transport layer is responsible for

- Service-point addressing

Computers often run several programs at the same time. For this reason, source-to-destination delivery means delivery not only from one computer to the next but also from a specific process (running program) on one computer to a specific process (running program) on the other. The transport layer header therefore must include a type of address called a service-point address (or port address). The network layer gets each packet to the correct computer; the transport layer gets the entire message to the correct process on that computer

The transport layer is responsible for

- Segmentation and reassembly

A message is divided into transmittable segments, each segment containing a sequence number. These numbers enable the transport layer to reassemble the message correctly upon arriving at the destination and to identify and replace packets that were lost in the transmission.

The transport layer is responsible for

- Connection control

The transport layer can be either connectionless or connection-oriented. A connectionless transport layer treats each segment as an independent packet and delivers it to the transport layer at the destination machine. A connection-oriented transport layer makes a connection with the transport layer at the destination machine first before delivering the packets. After all the data are transferred, the connection is terminated.

The transport layer is responsible for

- Flow control

Like the data link layer, the transport layer is responsible for flow control. However, flow control at this layer is performed end to end rather than across a single link.

The transport layer is responsible for

- Error control

Like the data link layer, the transport layer is responsible for error control. However, error control at this layer is performed end to end rather than across a single link. The sending transport layer makes sure that the entire message arrives at the receiving transport laver without error (damage, loss, or duplication). Error correction is usually achieved through retransmission.

The transport layer

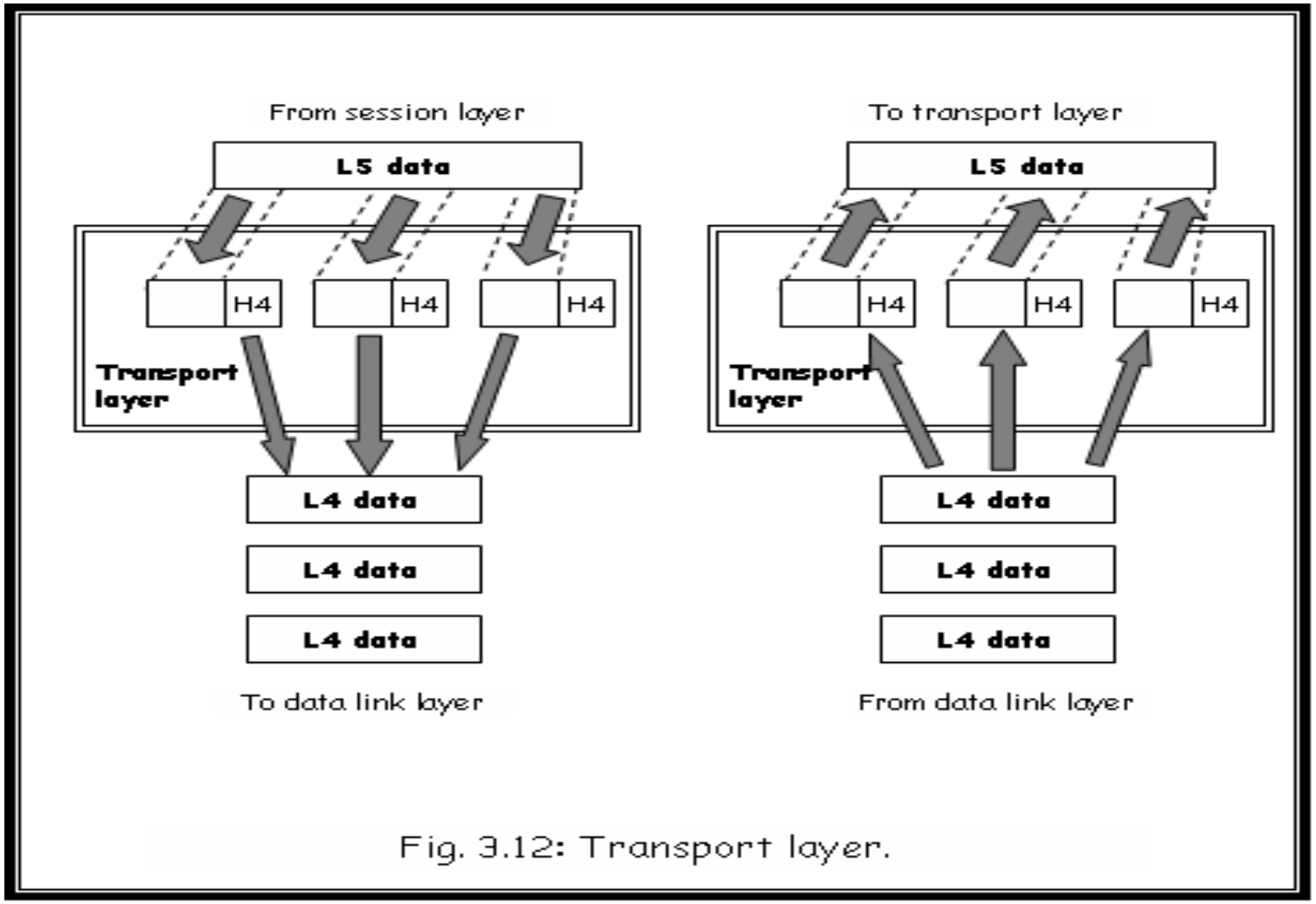


Fig. 3.12: Transport layer.

The session layer

- The Session Layer allows users on different machines to establish sessions between them.
- It's main aim is to establish, maintain and synchronize the interaction between communicating systems. Session layer manages and synchronize the conversation between two different applications. In Session layer, streams of data are marked and are resynchronized properly, so that the ends of the messages are not cut prematurely and data loss is avoided.
- **The key services provided by the session layer include:**
  - Dialogue Discipline
  - Grouping
  - Recovery

The session layer

- Dialogue Discipline (control):

This can be two-way simultaneous (full duplex) or two–way alternate (half duplex).

- Grouping:
  - The flow of data can be marked to define groups of data.
- Recovery (**Synchronization)** :
  - This layer allows a process to add checkpoints which are considered as synchronization points into stream of data. Example: If a system is sending a file of 800 pages, adding checkpoints after every 50 pages is recommended. This ensures that 50 page unit is successfully received and acknowledged. This is beneficial at the time of crash as if a crash happens at page number 110; there is no need to retransmit 1 to100 pages.
  - The following figure illustrates the relationship of the session layer to the transport and presentation layers.

The session layer

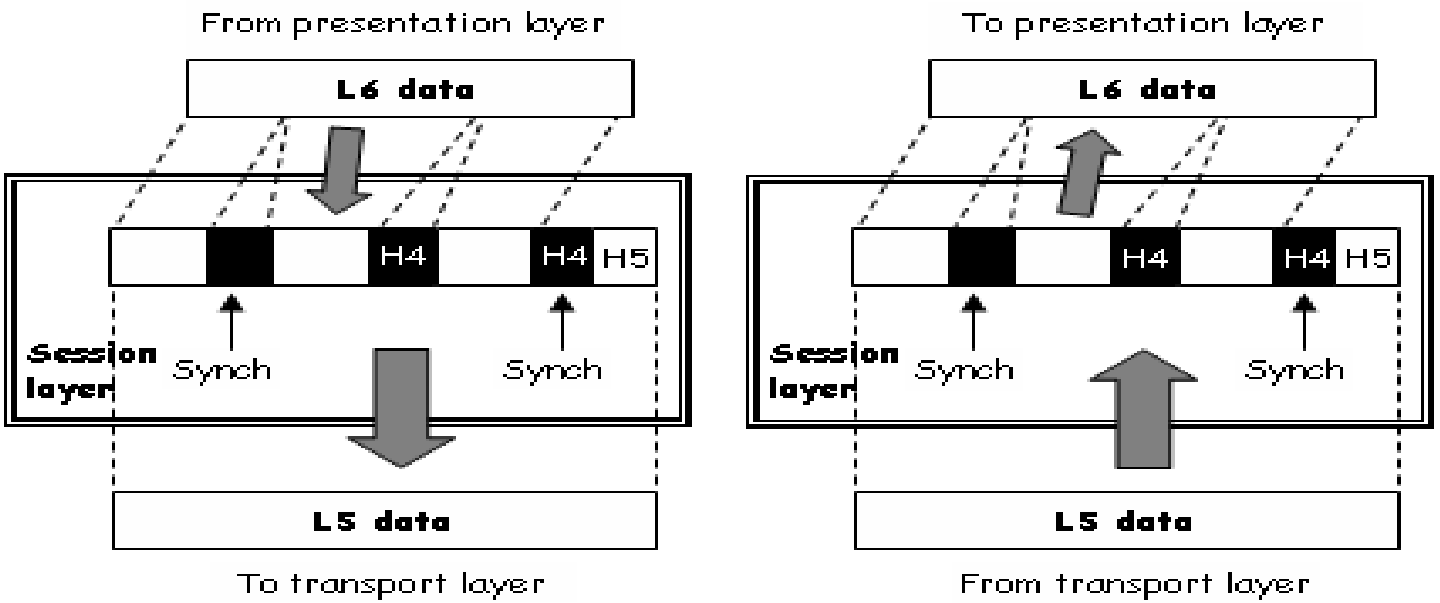


Fig. 3.14: Session layer.

The presentation layer

- **Specific responsibilities of the presentation layer include the following:**
  - **Translation:** Before being transmitted, information in the form of characters and numbers should be changed to bit streams. The presentation layer is responsible for interoperability between encoding methods as different computers use different encoding methods. It translates data between the formats the network requires and the format the computer.
  - **Encryption**: It carries out encryption at the transmitter and decryption at the receiver.
  - **Compression**:It carries out data compression to reduce the bandwidth of the data to be transmitted. The primary role of Data compression is to reduce the number of bits to be transmitted. It is important in transmitting multimedia such as audio, video, text etc.

The presentation layer

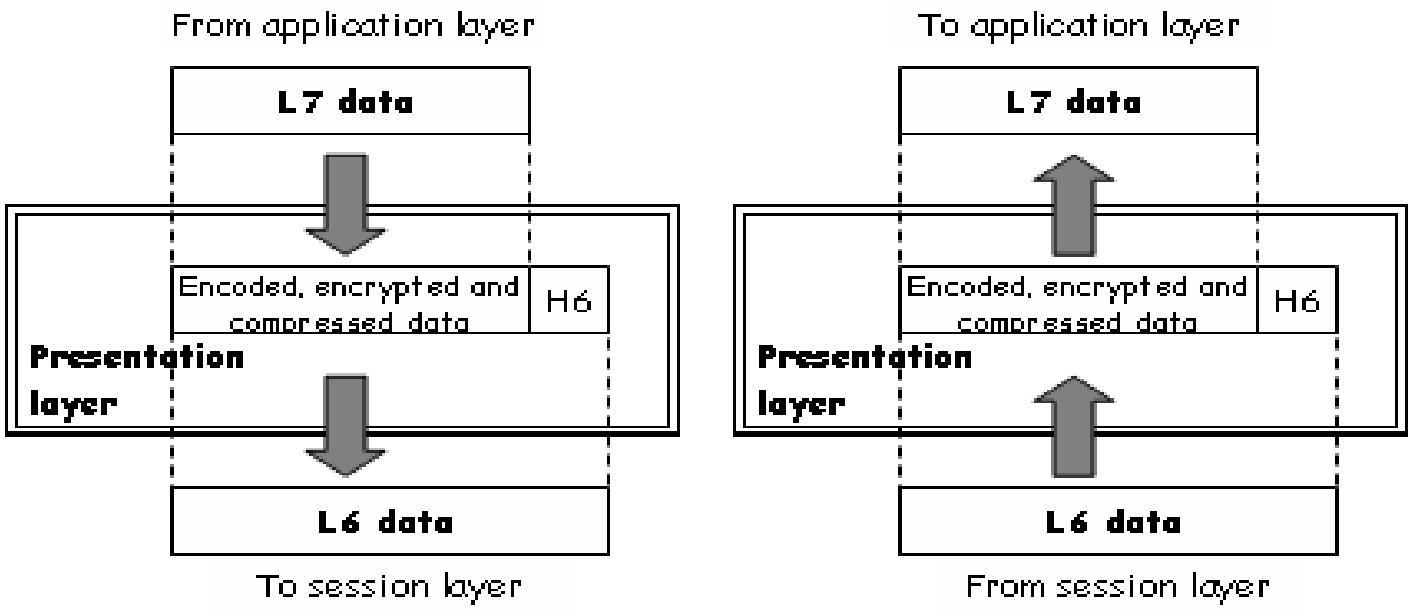


Fig. 3.15: Presentation layer.

The application layer

- It is the top most layer of OSI Model. Manipulation of data(information) in various ways is done in this layer which enables user or software to get access to the network. Some services provided by this layer includes: E-Mail, transferring files, distributing the results to user, directory services, network resources, etc.
- The Application Layer contains a variety of protocols that are commonly needed by users. One widely-used application protocol is **HTTP(HyperText Transfer Protocol)**, which is the basis for the World Wide Web. When a browser wants a web page, it sends the name of the page it wants to the server using HTTP. The server then sends the page back.
- Other Application protocols that are used are: **File Transfer Protocol(FTP)**, **Trivial File Transfer Protocol(TFTP)**, **Simple Mail Transfer Protocol(SMTP)**, **TELNET**, **Domain Name System(DNS)**etc.

The application layer

Specific services provided by the application layer include the following:

- Telnet
- File transfer, access, and management (FTAM)
- Mail services
- Directory services

The application layer

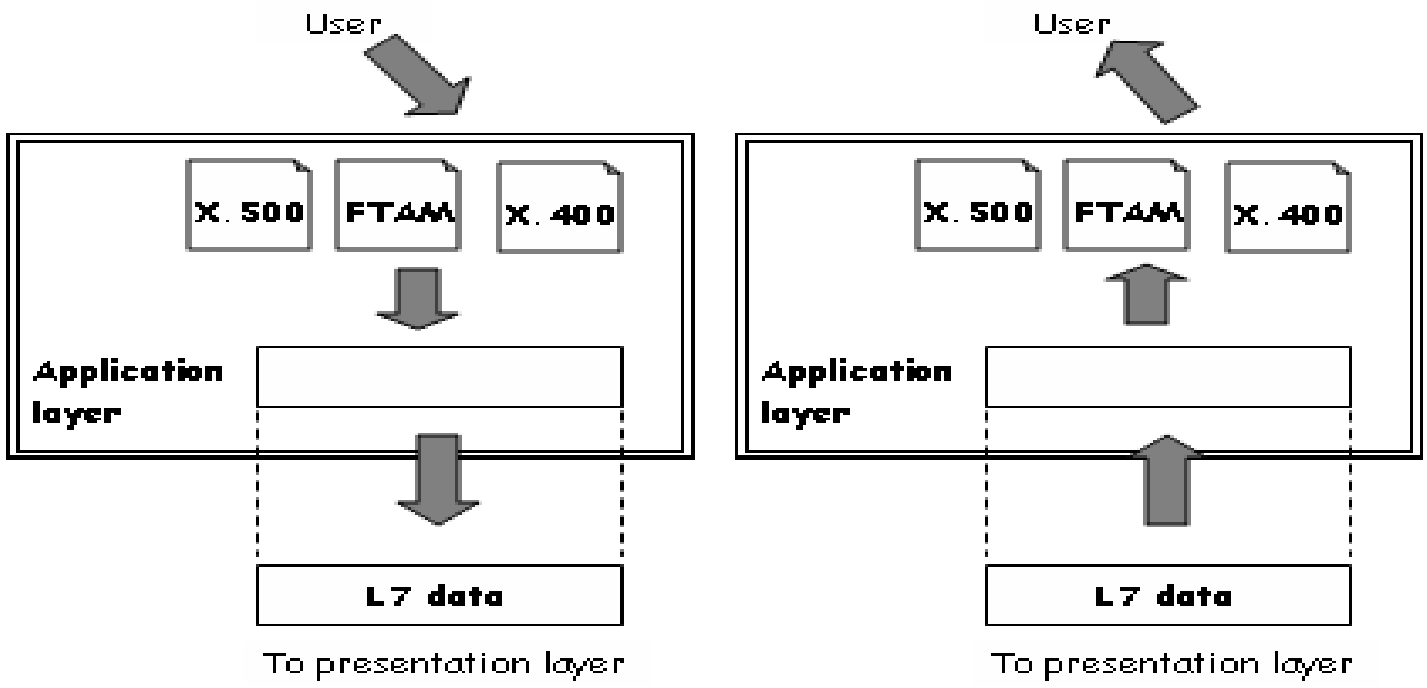
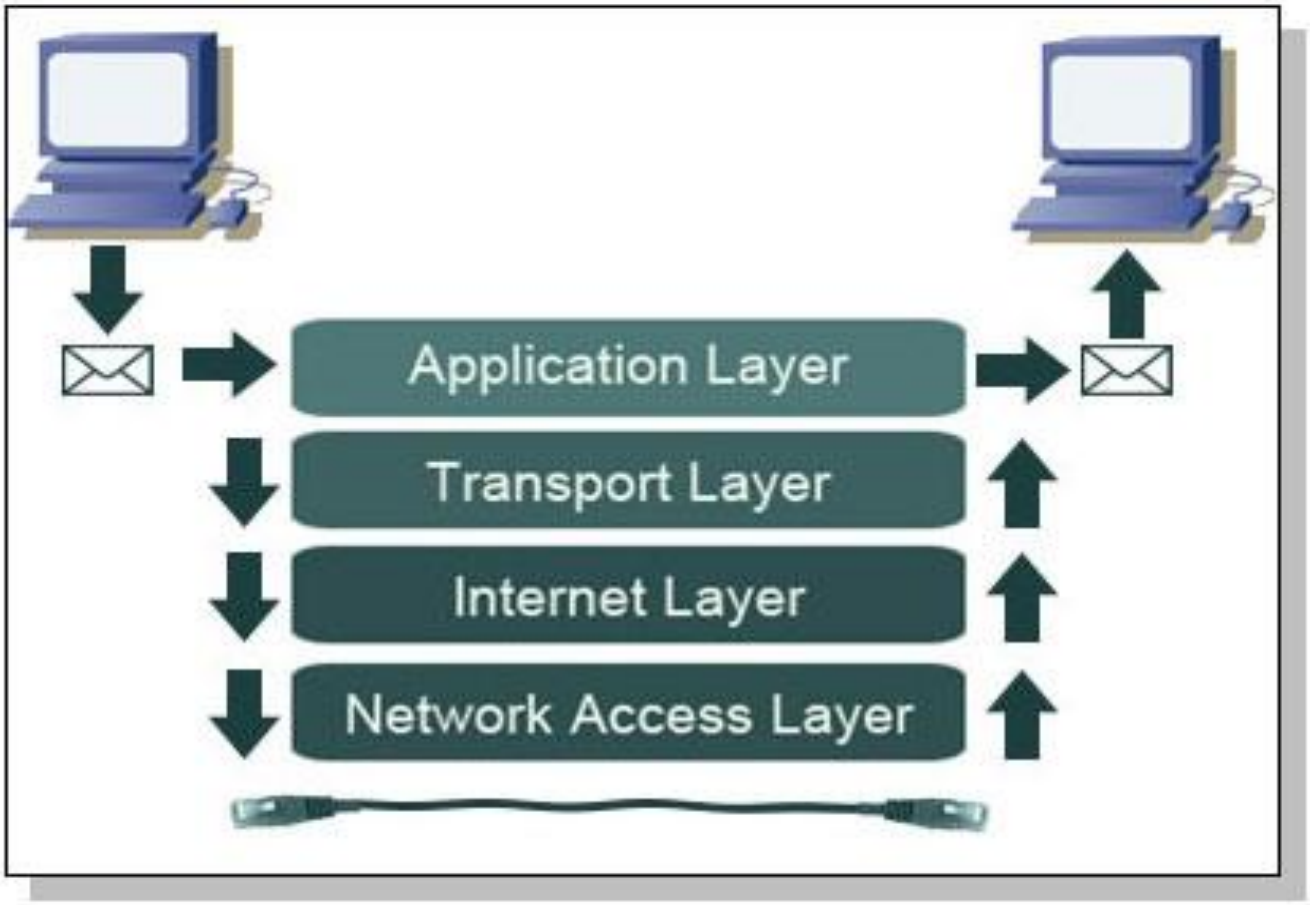


Fig. 3.16: Application layer.

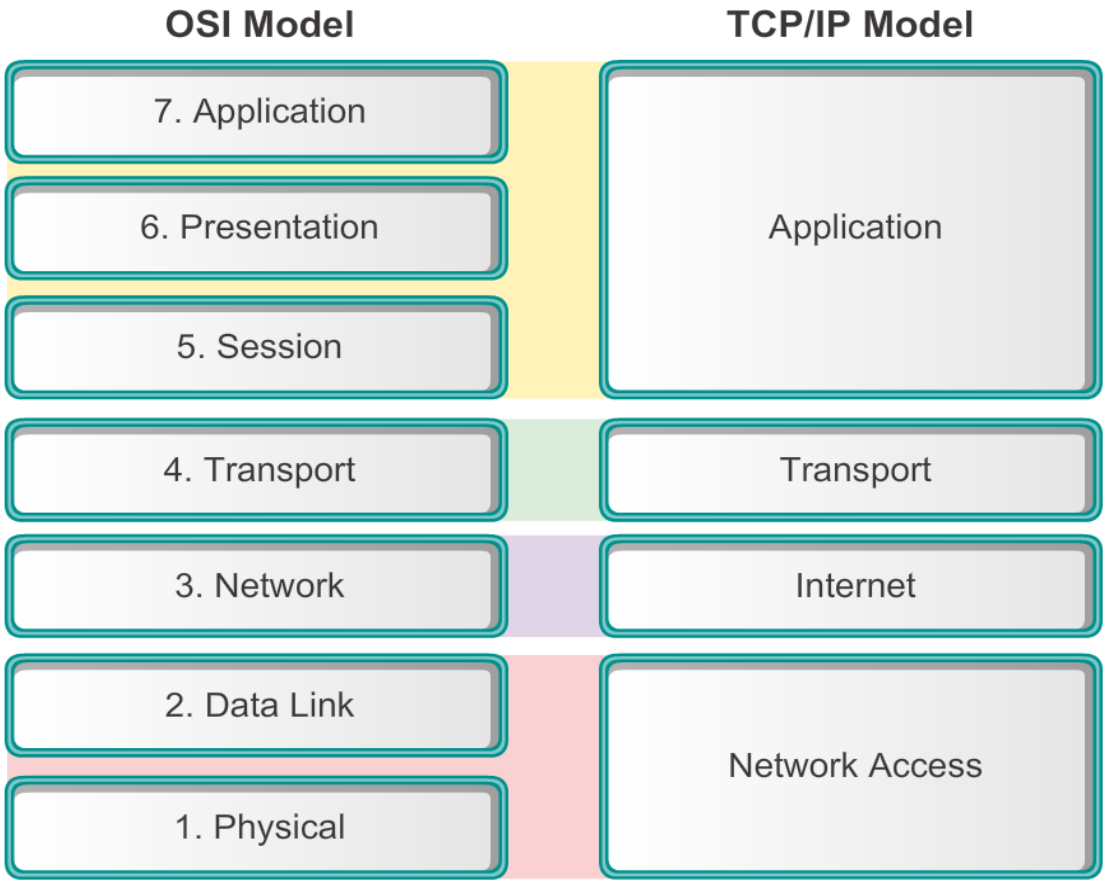
Reference Models

The TCP/IP Reference Model



Reference Models

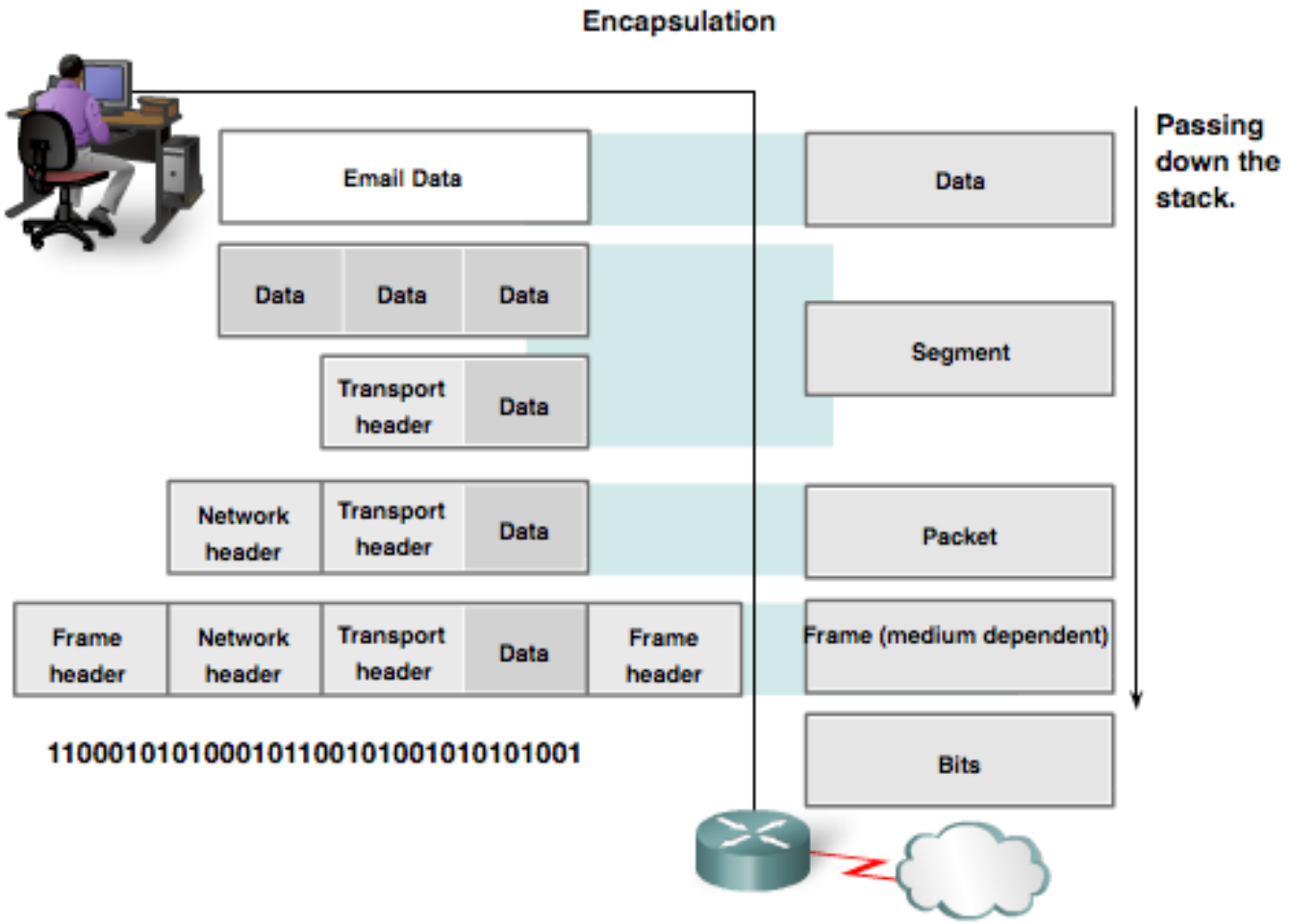
Comparing the OSI and TCP/IP Models



Data Encapsulation

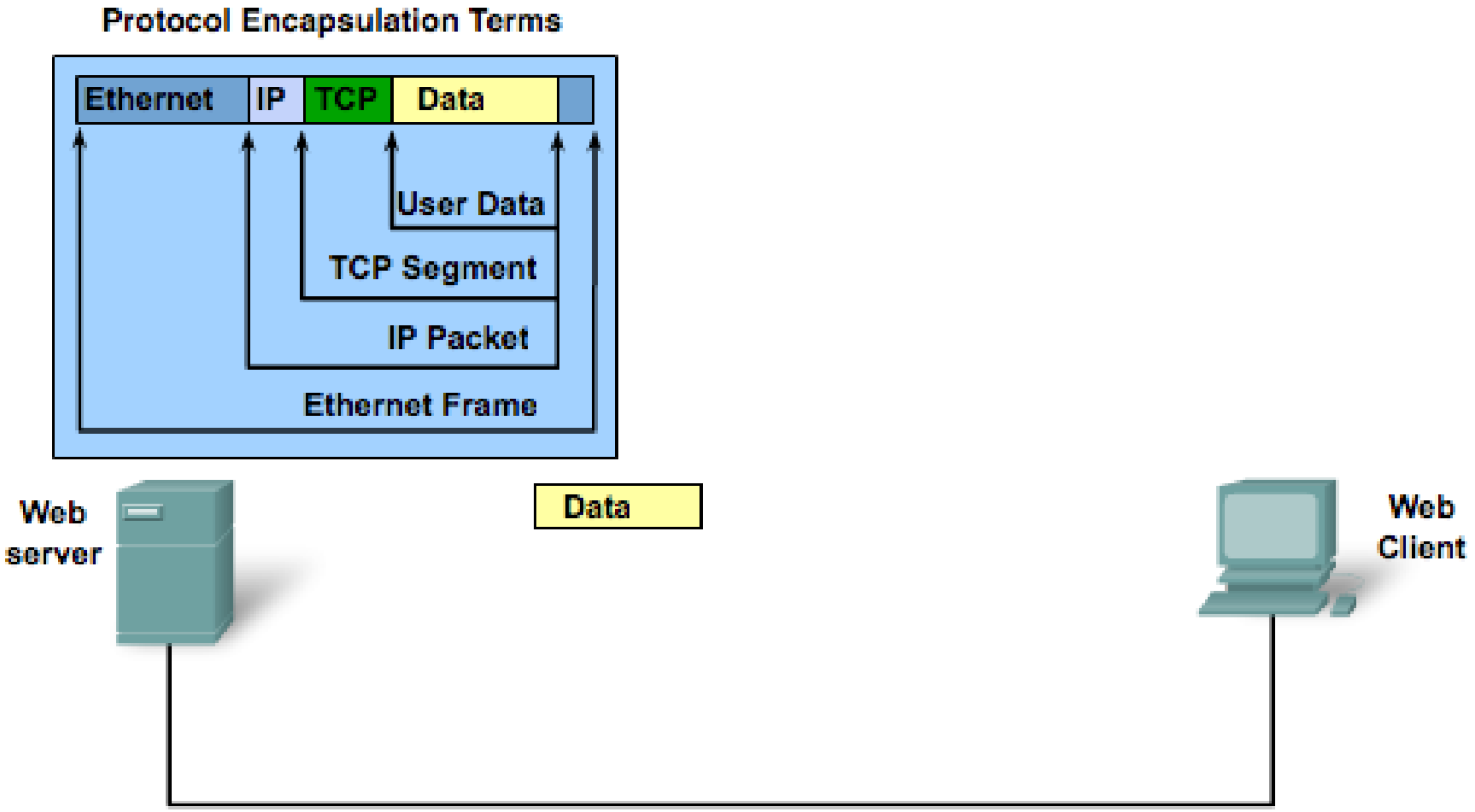
Protocol Data Units (PDUs)

- Data
- Segmen
- Packet
- Frame
- Bits



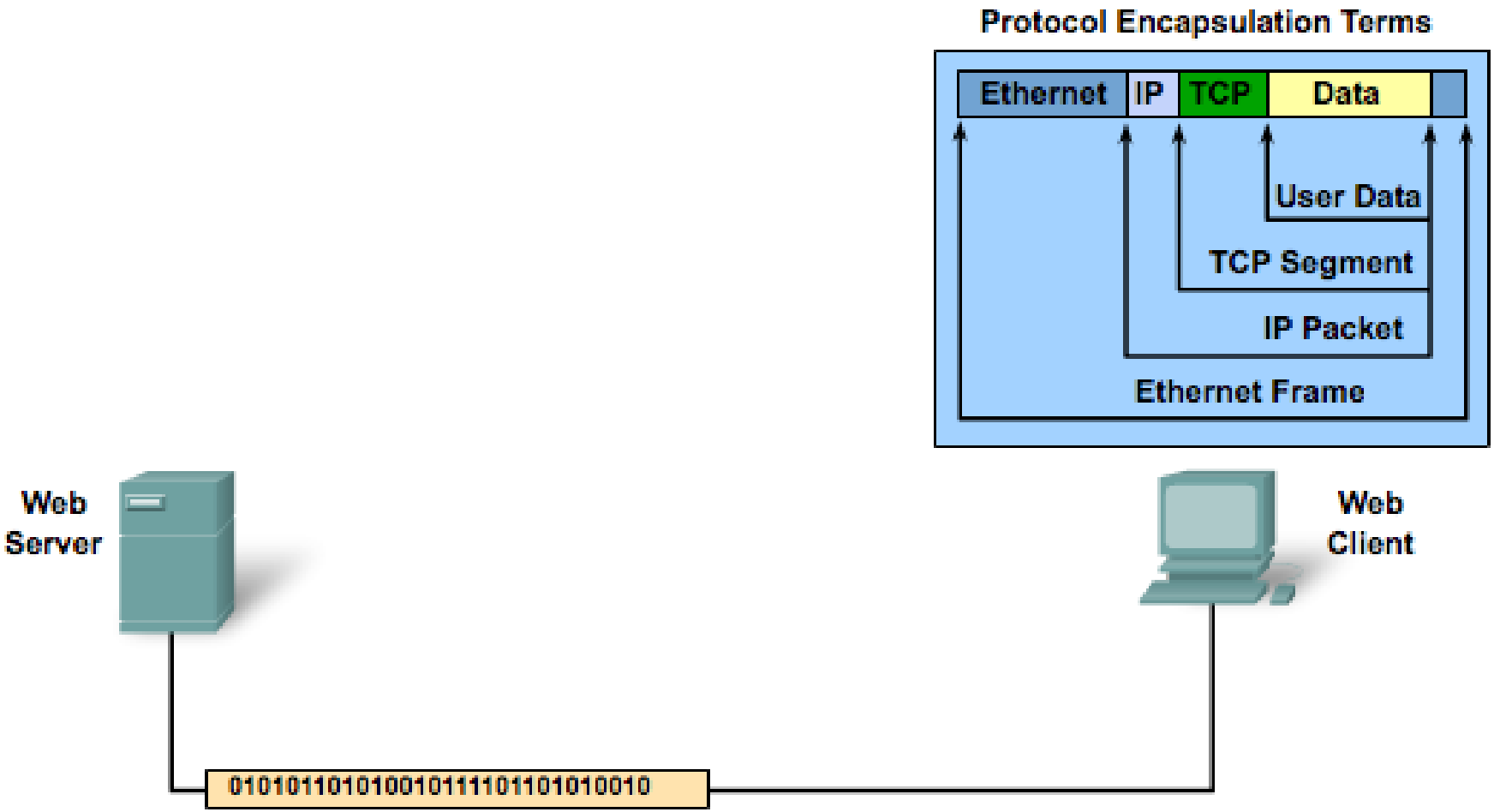
Data Encapsulation

Encapsulation



Data Encapsulation

De-encapsulation

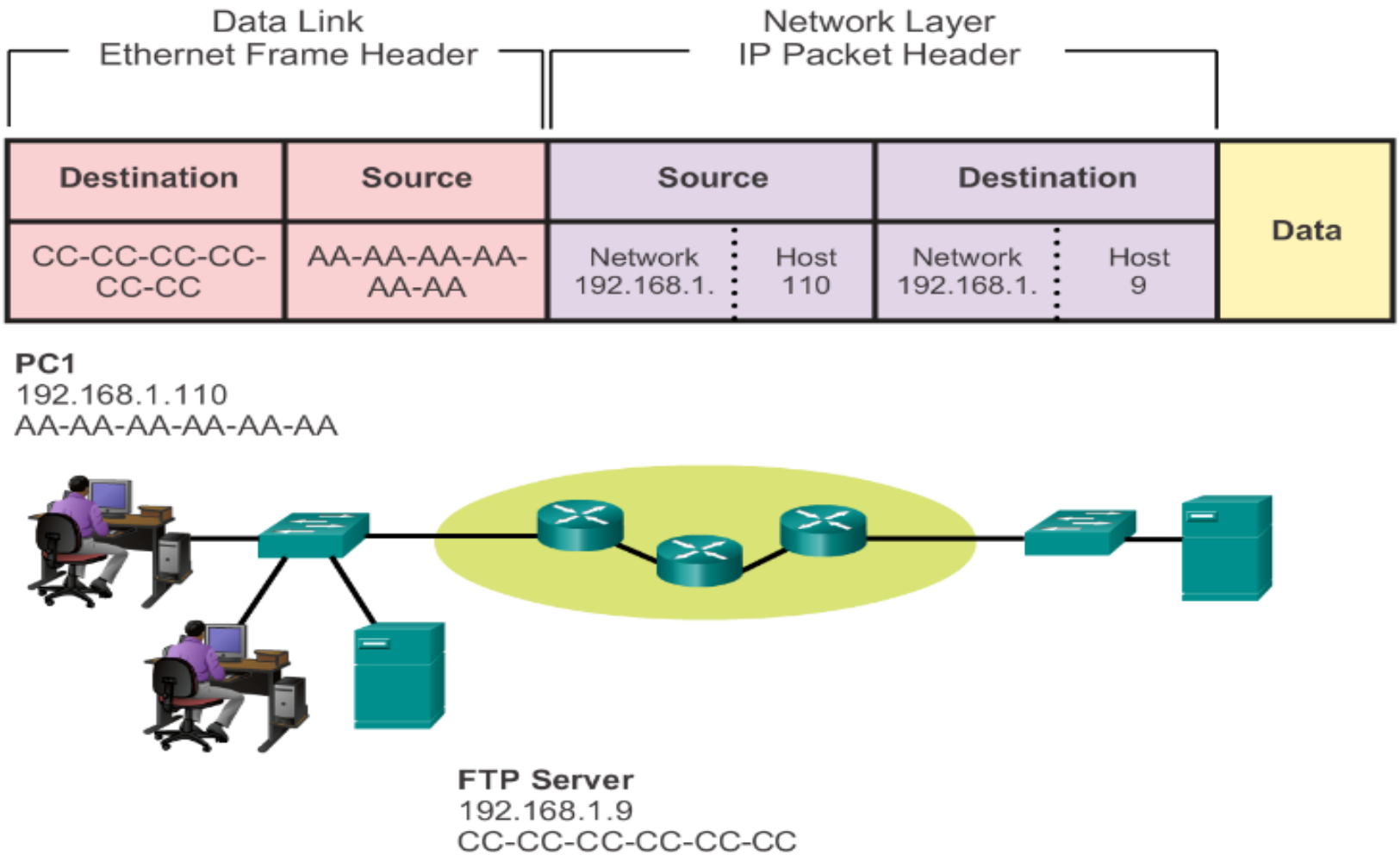


Network Addresses & Data Link addresses

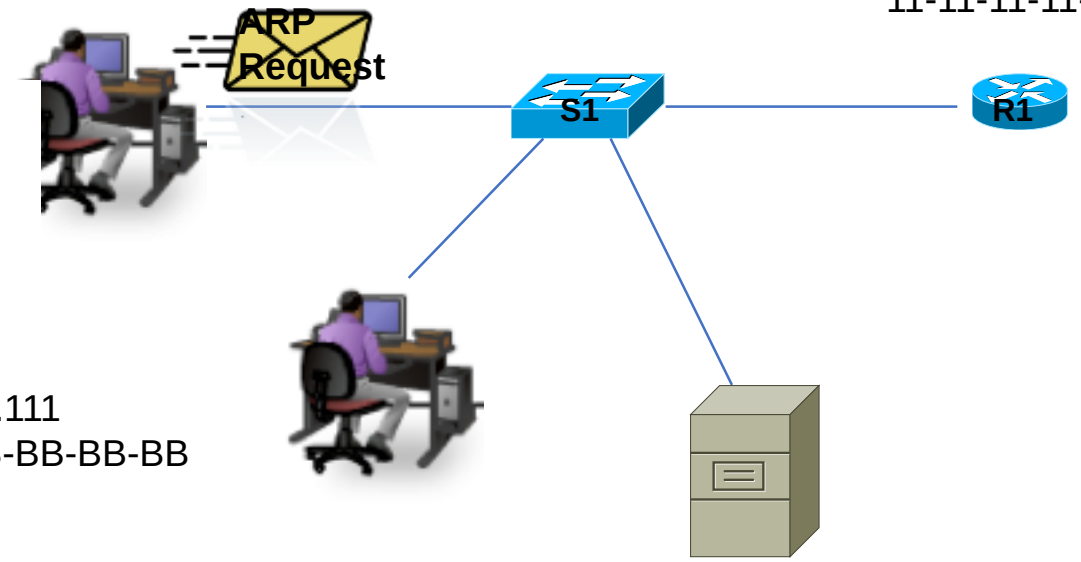
- Network Address
  - Source IP address
  - Destination IP address

- Data Link Address
  - Source data link address
  - Destination data link address

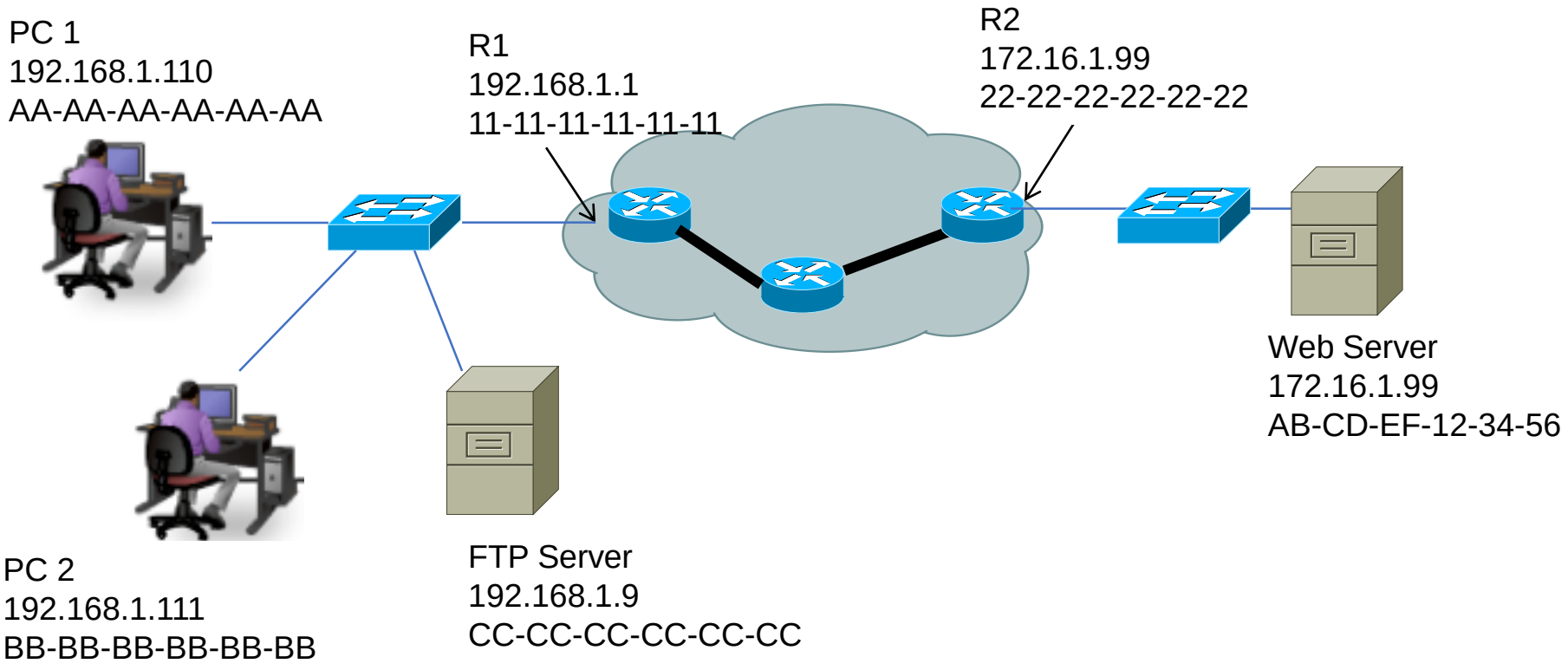
Communicating with Device / Same Network



MAC and IP Addresses



Default Gateway: A default gateway serves as an access point or IP router that a networked computer uses to send information to a computer in another network or the internet. Default simply means that this gateway is used by default.



Communicating Device / Remote Network